# Showcase Demonstration CASE STUDY

a Program of the U.S. Department of Energy

# THE CHALLENGE: SAVING ENERGY AT A SEWAGE LIFT STATION THROUGH PUMP SYSTEM MODIFICATIONS

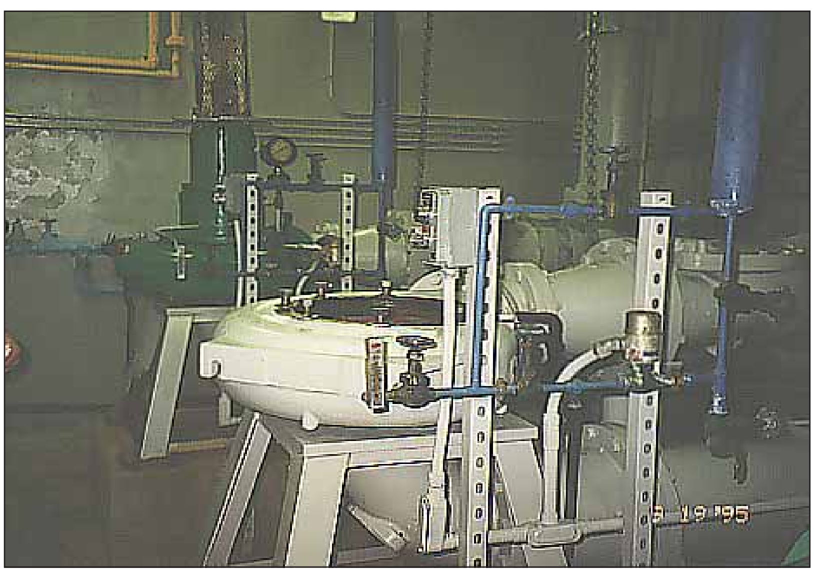

## Summary

The City of Milford wanted a way to save energy at the Welches Point sewage lift station. By adding a small booster pump to the sewage pumping system, the city reduced the station's annual energy consumption by 36,096 kWh which resulted in annual savings of $2,960. This Motor Challenge Showcase Demonstration project resulted in the City of Milford reducing energy consumption by over 15 percent at their Welches Point pump station. With a total implementation cost of $16,000, the project yielded a simple payback of 5.4 years. The lessons learned from this project will be applied to other sewage stations throughout the city.


| Project Profile | |
|---|---|
| **Industry:** | Sewage System |
| **Process:** | Sewage Pumping |
| **System:** | Pump System |
| **Technology:** | Booster Pump, Energy-Efficient Motor |

## Background

The City of Milford, located just south of New Haven, Connecticut, operates 37 sewage stations that serve more than 48,000 people. More than 7 million gallons of raw sewage is transported each year to one of two city sewage treatment plants.



*Welches Point Sewage Lift Station*

## Project Overview

A medium-sized sewage station built in 1963, the Welches Point pump station handles approximately 750 million gallons of raw sewage per year and consumes an estimated 240,000 kWh of electricity annually. It is one of many stations located throughout the City of Milford delivering sewage to the local treatment plants. The system operates with three identical 75-hp pumps which are vertically mounted 40 feet below ground level. The pumps

*The energy savings network*

*Plug into it!*

are driven by motors positioned directly above each pump at ground level. Each pump is equipped with a 35-foot floating line shaft that pumps raw sewage to a common header which gradually steps up to ground level. From the common header, the sewage flows through the gravity feed header (shared by several sewage stations) to the main treatment plant. To evaluate the system's efficiency, an analysis of volume flow, operating times, and energy use of the pumps was performed by the Showcase Demonstration team.

**City of Milford, Connecticut**

**SIC:** 4952

**Services:** Sewage Pumping

**Location:** Milford, Connecticut

**Employees:** 26

**Showcase Team Leader:** Art Berube

**Company Energy Philosophy:** Changes in energy conservation must take place without any detrimental effects on system reliability. Conservation and reliability go hand in hand in the wastewater field.

## Project Team

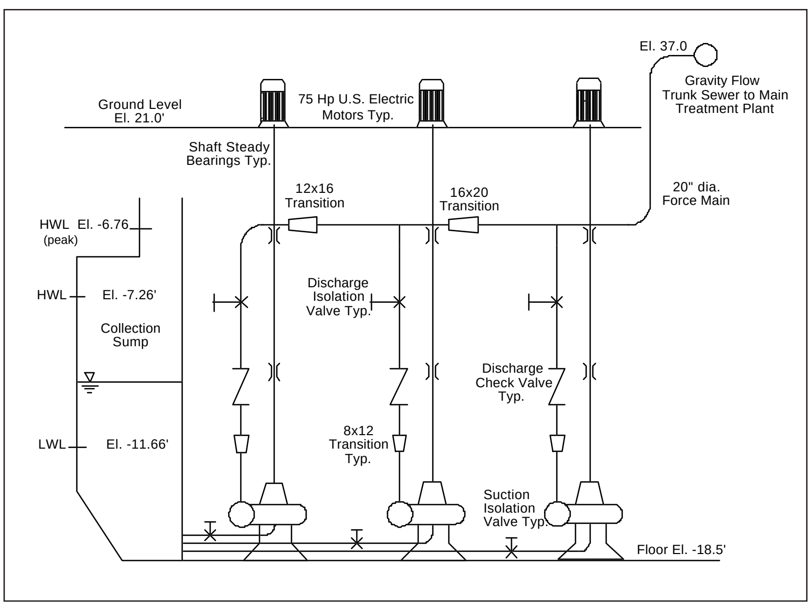
In addition to the sewage engineers employed by the City of Milford, the Showcase Demonstration project team included several consultants from ITT Flygt Corporation, the manufacturer of the new pump used in the project, and United Illuminating Company (the local electric utility) which provided electric metering services.

## Project Implementation - The Systems Approach

To determine whether or not energy savings could be realized at the lift station, team engineers developed a test plan based upon the systems approach. The systems approach is a way to increase the efficiency of an electric motor system by shifting the focus away from the individual elements and functions to total system performance. After performing an analysis of the overall performance of the station's pumping system, the project team concluded that reducing pump capacity could achieve significant energy savings.

## The Old System

The old system was designed to operate with only one pump under normal conditions. One of the pumps begins operating when the water level reaches a set high-water level and remains on until the water drops to a designated low-water level. During periods with very heavy inflow rates, two pumps operate simultaneously. A third pump functions as a back-up pump, operating if another pump is damaged or in repair. Each pump rarely operates for more than 15 minutes during each cycle.




*Welches Point Pump Station Schematic*

The sewage station was designed to handle peak inflow of 3,000 gallons per minute (gpm). The average inflow rate of sewage is 1,700 gpm. Average flow rates from the station to the local treatment plant were estimated at 3,350 gpm during normal conditions and 4,250 gpm when two pumps operate. Each year, the old system consumed approximately 212,064 kWh of electricity to handle 752 million gallons of sewage. Overall system efficiency was rated at 73 percent. To increase the efficiency level of the system, alternatives were considered based on the volume flow rates of the system.

## Alternatives Considered

Several alternatives to improve sewage station efficiency were considered. All centered around finding a way to pump the water out of the sump more slowly, which would reduce dynamic head loss, friction in the piping system, and energy consumption. To reduce the outflow rate, engineers considered installing variable frequency drives (VFDs) on each of the pumps to allow for variable speed control. VFDs can save energy in applications involving fast or frequent changes in flow rates. Because the sump acted as a buffer in this application, the outflow rate did not need to be changed frequently, so VFDs were not the answer. Also, VFDs are not generally recommended for systems with large static heads, like this one. Other options explored involved trimming the impeller or replacing the original pumps. After analyzing the tests performed on the original pumping units, the team concluded that the best solution would be to install a smaller pump to operate at lower outflow rates for longer running periods.

*Sewage Pump*

### The New System

The new system includes a smaller 4" x 8" pump that replaced one of the original three pumps. The smaller pump is driven by a 35-hp motor. This pump operates for longer periods, one to two hours on average, but at a lower outflow rate. The lower outflow rate results in reduced friction in the piping system, which reduces energy consumption. The original two pumps will no longer operate under normal conditions, but will run during periods with heavy inflow rates.

### Results

The optimized system delivers sewage to the main treatment plant at an average flow rate of 1,930 gpm under normal conditions. Energy consumption after installing the smaller pump is estimated to be 175,968 kWh per year resulting in a reduction of more than 37,000 kWh each year. Compared to the old system, the new system reduces annual energy use by more than 15 percent, equivalent to $2,960 in annual energy savings. With a total project implementation cost of $16,000, the City of Milford will realize a simple payback of 5.4 years.

In addition to the energy savings achieved, other direct benefits from modifying the system include increased equipment life and reduced equipment downtime and repair. Frequent starting and stopping of the pumps contributes significantly to wear-and-tear of the equipment and increases the associated maintenance required. With the new system, less stress is placed on equipment.

### Why Adding a Small Booster Pump Saved Energy

Sewage lift stations are simple sump systems. Water enters into the sump, and when it reaches a predetermined level, the pump turns on and empties the reservoir. A larger pump will generally use more energy than a smaller one because it will operate at a higher outflow rate. The higher outflow rate increases friction losses in the piping, which results in more energy being consumed to pump each gallon of water. Adding the small booster pump to the Milford Station allowed the system to operate at greatly reduced outflow rates during normal conditions, reducing energy consumption significantly.

## Lessons Learned

In modifying the sewage station, the City of Milford not only saved energy, it also learned several important lessons that can be applied to other city energy efficiency projects: (1) New energy saving opportunities may be discovered when using a total systems performance methodology. By utilizing this methodology, the City of Milford found an innovative solution to reduce energy use; (2) Additional energy savings may be achieved by adjusting pumps to allow for variable flow rate application. In this project, stepping of pumps led to a significant increase in overall operational efficiency; (3) Replacing the original motors with energy-efficient motors also helps to reduce energy consumption.

| Performance Improvement Summary | |
|---|---|
| **Energy and Cost Savings** | |
| Project Implementation Costs | $16,000 |
| Annual Energy Cost Savings | $2,960 |
| Simple Payback (years) | 5.4 |
| Demand Savings (kW) | 30 |
| Annual Energy Savings (kWh) | 36,096 |
| **Total Annual Emissions Reductions** | |
| $CO_2$ | 45,481 lbs |
| Carbon Equivalent | 12,404 lbs |
| $SO_x$ | 266 lbs |
| $NO_x$ | 61 lbs |
| PM10 | 6 lbs |
| CO | 7 lbs |
| VOC | 1 lb |

## About Motor Challenge

The Motor Challenge is a joint effort by the U.S. Department of Energy (DOE), industry, motor systems equipment manufacturers and distributors, and other key stakeholders to put information about energy-efficient electric motor system technology in the hands of people who can use it.

Showcase Demonstration Projects target electric motor-driven system efficiency and productivity opportunities in specific industrial applications. They show that efficiency potential can be realized in a cost-effective manner and encourage replication at other facilities.

DOE provided technical assistance and independent performance validation (IPV) of energy savings. A DOE-sponsored IPV team reviewed the test plan and provided assistance, as requested by the host site, on testing procedures, instrumentation techniques, and data acquisition. The DOE team developed a detailed IPV Report thoroughly documenting the project. The Report is available by calling the number listed below. DOE did not witness the actual test data, and the conclusions in this case study are based solely on data provided by the host site and their partners.

For more information on becoming involved in the Motor Challenge or sponsoring a Showcase Demonstration, call the Motor Challenge Information Clearinghouse at (800) 862-2086.

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MOTOR CHALLENGE

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